Barriers to universal child immunization in rural Senegal 5 years after the accelerated Expanded Programme on Immunization

A. Desgrées du Loû[1] & G. Pison[1]

Although the Expanded Programme on Immunization (EPI) has been a worldwide success, weak points remain, particularly in Africa. In Senegal, for example, immunization coverage was low in 1990 (60%), in part because of poor results in rural areas. In order to identify obstacles to EPI in such areas, we carried out an immunization survey in Bandafassi, a rural area of Senegal, where 6078 inhabitants lived in 23 small villages.

Only 41% of children aged 1–10 years were completely vaccinated in February 1992, with considerable variations in coverage from one village to another, according to their geographical location: 71% of children were completely vaccinated in villages less than 10 km from the health centre, whereas in remote villages only 10% of children had been completely vaccinated. There was no variation according to ethnic group. From 1987 to 1992, the gap in immunization coverage between the remote villages and those located close to the health centre has steadily increased.

There is a need to improve the performance of the mobile teams in the remote villages and to increase awareness about the importance of immunization.

Introduction

In 1977 the World Health Assembly approved the goal of providing immunization for all the world's children by 1990 through the Expanded Programme on Immunization (EPI). In 1988, the EPI Global Advisory Group stressed the need to increase the immunization level of all children to at least 80% by 1990 and to at least 90% by the year 2000 (*1*).

The success of EPI depends, in part, on regular evaluation of its activities in order to identify any obstacles that it may be encountering. Despite considerable efforts over the previous 10 years in Senegal, in 1990 only 51% of under-12-month-olds had been immunized with three doses of diphtheria–pertussis–tetanus (DPT) and poliovirus vaccines, while 93% and 69%, respectively, had been immunized against tuberculosis and measles,[a] levels that are far below the 80% objective mentioned above. In this article we identify obstacles to EPI on the basis of a vaccination survey carried out in a rural area of Senegal.

The survey provided full information on the vaccination status of children aged 1–10 years in the Bandafassi area (Kedougou *département*, Tambacounda Region). The data obtained permit determination of the immunization coverage in the area in 1992 and its evolution over recent years, as well as an assessment of the impact of geographical, social, and demographic factors.

Population and methods

EPI in Senegal

Up to 1981, when EPI began in Senegal, only children living in towns had access to vaccination services and only a few children were immunized.[b] In 1981, EPI had as its objectives the extension of immunization to the rural areas of the country and the improvement of coverage in those areas where vaccination was already available. EPI's strategy is founded on both permanent vaccination centres and mobile teams; the permanent centres are in charge of vaccination within a radius of 15 km of where they are located, while the mobile teams vaccinate in rural villages that lie further than this from the nearest centre.

[1] Laboratoire d'Anthropologie Biologique (URA 49 du CNRS), Museum National d'Histoire Naturelle, Musée de l'Homme, 17 place du Trocadéro, 75116 Paris, France. Requests for reprints should be sent to Dr Pison.

[a] *Information system: summary for the WHO African Region, 1–36, 1993.* Unpublished document WHO/EPI/CEIS/93.1. The vaccine used in Senegal is the quadruple vaccine and contains DPT and inactivated poliovirus vaccine.

[b] **Kessler S et al.** *Rapport de la mission d'évaluation Rapide au Sénégal.* UNICEF, 1989 (Document 1–34).

Reprint No. **5525**

In the beginning, EPI recorded low coverage; in 1984, the proportion of children aged 12–23 months who were completely immunized was as low as 18%,[c] and in 1986 it was only 20%.[d] Subsequently, special campaigns were carried out, one in the first quarter of 1987 and the second in the first quarter of 1990. In each case, the administrative and health services received training and were fully mobilized, information was delivered to the entire population through the media (mainly radio), and new vaccination equipment was provided to health centres, especially in 1987. These efforts improved coverage: in July 1987, 35% of children aged 12–23 months were completely vaccinated; and in June 1990, 55% had received all vaccinations (BCG, 3 doses of diphtheria–pertussis–tetanus/poliovirus vaccine (DPT3/polio3), measles, and yellow fever).[c, e] The 1987 campaign focused more particularly on rural areas. Efforts consisted mainly in improving equipment and setting up mobile teams. This campaign raised immunization coverage in rural areas to levels close to those in the towns. In contrast, the 1990 campaign focused on the towns, since improvement of their vaccination coverage appeared to be too slow. Consequently, the national vaccination coverage improved, but at the same time, disparities between towns and rural areas reappeared.

The rural area of Bandafassi

The Bandafassi area is located close to the borders with Guinea and Mali. On 1 March 1992, 6078 persons were living in this area in 23 small villages. Bandafassi is one of the remotest locations in Senegal: Dakar, the national capital, is 700 km away, and Tambacounda, the regional capital, is 250 km away. Moreover, the roads are often blocked in the rainy season (May–November). Kedougou, the closest town, is 14–60 km away from the cluster of study villages.

The study area consists of a plain (average altitude, 100 m) and scattered hills and tablelands (average altitude, 300 m), and access is often difficult. Some villages are located on the plain, while others are in the highlands. Population density is low, about 10 inhabitants per km^2.

Two ethnic groups live in Bandafassi in separate villages: the Bedik (24% of the population) and the Fulbe (76% of the population). The Fulbe are Moslems, while the Bedik are largely animists, with a minority being Christians. Because of conflict with other ethnic groups at the end of the last century, Bedik villages are often remote. Fulbe villages are located both on the plain and in the hills.

Survey methods

The population of the area has been followed up since 1975 (2),[f] when a census was taken. All villages have since been visited each year in order to collect information on births, deaths, marriages and migrations that have occurred since the previous visit.[g] At each visit the chiefs of each village are asked questions about the vaccination sessions organized during the year.

In February 1992, we organized a specific immunization survey for children aged 1–10 years. A nominative list of all children in this range was prepared for each village, based on information collected during preceding years. Each mother was asked whether her child had been vaccinated and whether she had a vaccination card. If a card was presented, the date of administration of each vaccine was recorded (BCG, measles and yellow fever, DPT/polio1, DPT/polio2, DPT/polio3, and boosters). If no card was available, although the child had been vaccinated, we asked how many times he/she had been vaccinated. Nearly half of the vaccinated children had no vaccination card; often the cards had been thrown away, lost, or left in another village. We therefore based the analysis on the number of times a child had been vaccinated, rather than on the specific vaccines the child had received. It is important to note that in the study area children can be quite old when they are vaccinated for the first time, because most villages are visited by a vaccination team only once a year. Consequently, many children are vaccinated for the first time after 9 months of age; then they receive four vaccines at the same time (BCG, DPT/polio1, measles, and yellow fever). Children vaccinated before 9 months of age receive only BCG and DPT/polio1.

[c] **Claquin P et al.** *Rapport d'évaluation de la couverture vaccinale des enfants de 12 à 23 mois en République du Sénégal au 1er juillet 1987.* Dakar, 1987 (Document 1–76).

[d] **Ndiaye S et al.** *Enquête démographique et de santé au Sénégal 1986.* (Document 1–171). Direction de la Statistique, Dakar, and Westinghouse Institute for Resource Development, Demographic and Health Survey, Columbia, NY, 1988.

[e] **OCCGE-Muraz.** *Evaluation du programme élargi de vaccination (PEV) au Sénégal.* Bobo Dioulasso, 1990 (Document 1–197).

[f] The area covered by the demographic survey is somewhat larger than our vaccination study area. The 23 villages and 6078 inhabitants in our study are part of the 37 villages and 8398 inhabitants of the basic demographic survey.

[g] **Pison G et al.** Bandafassi: a 23 years' prospective community study in rural Senegal (1970–1993). In: Das Gupta, M et al., eds. *Socio-cultural determinants of morbidity and mortality in developing countries: the role of longitudinal studies* (in preparation).

Statistical analysis

The following factors that could have influenced a child's vaccination status were studied:

— distance between the child's village and the health centre;
— geographical location of the village (plain or hills);
— size of the village;
— child's ethnic group;
— mother's age;
— size of the compound where the child lives; and
— number of children living in the compound.

Those factors that were related to the child's vaccination status were determined using a univariate analysis.[h] A multiple logistic regression was then employed to measure the influence of each factor, controlling for the others.

According to the logistic model, the probability (P) of being vaccinated is given by the expression (*3*):

$$P = 1/[1 + \exp-(a + b_1X_1 + b_2X_2 + ...)]$$

where b_1, b_2... are parameters.

Use of this model gives the following odds ratio (OR) for factors X_1:

$$OR_1 = \exp(b_1)$$

with $OR_1 = P_1/(1-P_1) \div P_0/(1-P_0)$
where P_1 is the probability when $X_1 = 1$
and P_0 is the probability when $X_1 = 0$.

For each analysis, two levels of immunization were taken into account: minimal immunization — the child has been vaccinated at least once; and complete immunization — the child has been vaccinated at least three times.

Results

History and organization of vaccination

No general vaccination campaign had been carried out in the study area until 1982, apart from the national campaign against smallpox and measles in 1969. Between 1982 and 1986, vaccinations were carried out in a few villages when measles epidemics were reported. The situation changed completely with the national campaign of 1987, which covered almost all the villages.

There is only one health centre in the survey area, in the village of Bandafassi. The health attendant travels by motorcycle to villages less than 15 km from Bandafassi to vaccinate children. Vaccinations are carried out in the more distant villages by a mobile team, based in Kedougou. All vaccinations are necessarily performed during the dry season from December to April, since the population disperses during the rainy season and the roads are often inaccessible at that time of the year.

Vaccination coverage in Bandafassi

Situation in February 1992. The proportion of children aged 1–10 years who were completely vaccinated was only 41% (Table 1); 74% had been vaccinated at least once. Vaccination levels were similar for 2- and 3-year-olds: 42% had been vaccinated three times; and 76%, once. Levels were lower for children aged 12–23 months: 35% had been vaccinated three times; and 58%, at least once. The low levels for the 12–23-month-olds are partly explained by the date of the survey (February 1992), since most vaccinations are given between January and April. Hence, we used the 2–3-year-old age group rather than 12–23-month-olds as reference. These overall vaccination levels conceal great diversity (Table 1), the maximum vaccination coverage being 94% (vaccinated 3 times) and 100% (vaccinated at least once) and the minimum, 0% and 0%, respectively.

Determinants of vaccination status. The results of the univariate analysis are shown in Table 2, while those of the multivariate analysis are shown in Table 3.

A village's location (plain/hills) and its distance from the nearest health centre were always strongly related to the probability of a child being vaccinated; the farther the village from Bandafassi's health centre, the smaller the child's chance of being vaccinated (odds ratio: 0.88) (Table 3). Children living on the plain were vaccinated more frequently than those in the hills, with the differences being larger for the youngest children and for complete vaccination. For the age group 12–23 months, the relative risk (RR) was 36.4 (95% confidence interval (CI): 2.3–576.2) for complete vaccination, and 9.8 (95% CI = 5.33–18.05) for one vaccination. For all children aged 1–10 years, RR = 4.5 (95% CI = 3.49–5.9) for complete vaccination (Table 2).

The size of the village was significant for some age groups only. When it was significant, the chances of being vaccinated increased with the size of the village. For children aged 1–10 years, the

[h] For each quantitative factor, we created a homologous variable with two or three classes in order to make clearer the interpretation of the univariate analysis and of the relative risks.

Table 1: **Immunization coverage, and geographical, and demographic characteristics of the 23 study villages, Bandafassi, February 1992**

Village[a]	Distance to the health centre[b] (in km)	Location[c]	Ethnic group[d]	% of children vaccinated at least once, aged: 12–23 months	2–3 years	1–10 years	% of children vaccinated at least three times, aged: 12–23 months	2–3 years	1–10 years	Population[e]
Group A										
Nianie	9	P	F	100	100	100	86	94	94	161
Etchwar	1	P	B	100	100	80	100	94	72	203
Bundukundi	4	P	F	100	100	92	75	93	76	175
Bandafassi	0	P	F	100	97	91	91	83	71	309
Patassi	9	P	F	—	100	88	0	78	79	88
Ibel	9	P	F	100	96	97	70	68	62	763
Group B										
Ndebu	15	P	F	83	95	87	17	60	51	216
Landieni	12	P	F	100	94	92	0	50	53	167
Tioketian	15	P	F	50	88	87	0	47	47	285
Group C										
Tiabedji	24	P	F	83	73	80	0	27	23	576
Andyel	11	A	B	20	83	71	0	8	12	156
Lande Baïtil	21	A	F	0	56	60	0	6	23	619
Namel	23	P	F	9	50	54	0	4	11	271
Mangama	16	P	B	0	100	80	0	0	0	128
Angoussaka	19	A	F	0	71	73	0	0	41	170
Iwol	10	A	B	14	68	54	0	0	1	369
Inere	20	A	B	0	50	30	0	0	0	110
Kessema	21	A	F	0	43	55	0	0	25	162
Kenda	19	P	F	0	43	55	0	0	14	81
Etyes	22	A	B	0	25	39	0	0	0	497
Bandi	16	P	F	100	25	23	0	0	0	46
Assoni	35	P	F	0	17	16	0	0	0	309
Tiarmalel	29	P	F	0	0	20	0	0	0	217
Total										
Group A				100	97	93	77	79	71	1 699
Group B				73	92	89	9	53	50	668
Group C				16	51	51	0	4	10	3 711
Overall total				58	76	74	35	42	41	6 078

[a] Villages are arranged in decreasing proportion of children aged 2–3 years who had been vaccinated three times. Group A: villages whose distance to the health centre is <10 km. Group B: villages whose distance to the health centre is 10–15 km. Group C: villages >15 km from the health centre.
[b] By car or motorcycle.
[c] A = at altitude, P = on the plain.
[d] B = Bedik ; F = Fulbe.
[e] On 1 March 1992.

relative risk of being vaccinated three times was 0.5 (95% CI = 0.37–0.71) in a small village (Table 2). In the multivariate model, the size of the village was significantly related to the chance of being vaccinated once, but was not related to the chance of being vaccinated three times (Table 3).

Both the size of the compound and number of children living in it were significantly related to being vaccinated. The chances of being vaccinated were significantly higher in a small compound with few children. RR = 1.7 for children aged 2–3 years (95% CI = 1.29–2.34) in small compounds (Table 2); however, these factors were not significant in the multivariate regression analysis.

In the univariate analysis, ethnic group seemed to affect coverage, the relative risk being 0.4 (95% CI = 0.31–0.5) for a Bedik child compared with a Fulbe child (Table 2). However, ethnic group was strongly related to the distance from the nearest health centre and location: most Bedik villages are in the hills and are difficult to reach. When we controlled for location, the relationship between ethnic

Table 2: **Univariate analysis: relative risk of being vaccinated, according to age and to geographical, demographic, and social factors, Bandafassi, February 1992**

Factors	Relative risk for children aged: 12–23 months[a] — No. of times vaccinated: At least once	12–23 months[a] — Three	2–3 years[a] — At least once	2–3 years[a] — Three	1–10 years[a] — At least once	1–10 years[a] — Three
Village						
Plain versus hills	**9.8[b] (5.33–18.05)[c]**	**36.4[d] (2.3–576.2)**	**1.3 (1.13–1.6)**	**16 (7.3–35.3)**	**1.4 (1.31–1.56)**	**4.5 (3.49–5.9)**
No. of inhabitants 0–149 versus >149	**0.4 (0.21–0.76)**	**0.1[d] (0–1.2)**	1 (0.74–1.26)	0.7 (0.39–1.38)	**0.8 (0.68–0.89)**	**0.5 (0.37–0.71)**
Ethnic group						
Bedik versus Fulbe	**0.3 (0.19–0.52)**	**0.3 (0.11–0.64)**	0.8 (0.7–1)	**0.6 (0.38–0.88)**	**0.8 (0.71–0.84)**	**0.4 (0.31–0.5)**
Controlling for location	1.8 (0.88–3.68)	2.3 (0.98–5.28)	1 (0.81–1.25)	**1.6 (1.09–2.39)**	0.96 (0.86 to 1.08)	0.89 (0.72 to 1.1)
Size of compound (inhabitants)						
0–11 versus >11	**1.6 (1.22–2.13)**	**1.4 (0.87–2.22)**	1.2 (1–1.36)	**1.7 (1.29–2.34)**	**1.1 (1.01–1.19)**	**1.2 (1.05–1.44)**
No. of children in the compound						
0–7 versus >7	**1.7 (1.25–2.3)**	1.4 (0.88–2.36)	1.1 (0.95–1.26)	**1.9 (1.35–2.59)**	**1.1 (1–1.21)**	**1.3 (1.13–1.52)**
Distance between the village and the health centre (km)						
0–9 versus >15	**7.7 (5.01–11.72)**	**66.6[d] (4.2–1 054.3)**	**2.3 (1.9–2.74)**	**37.4 (19.8–70.6)**	**1.9 (1.78–2.11)**	**5.9 (4.82–7.25)**
10–15 versus >15	**2.9 (1.3–6.46)**	**8.7[d] (0.46–162.5)**	**1.9 (1.5–2.5)**	**15.3 (5.6–41.7)**	**1.5 (1.34–1.7)**	**2.3 (1.67–3.11)**
Age of the mother (years)						
<20 versus >40	0.7 (0.41–1.19)	0.4 (0.1–1.56)	0.8 (0.54–1.3)	0.9 (0.46–2)	0.8 (0.61–1.12)	0.9 (0.52–1.58)
20–29 versus >40	0.6 (0.41–1)	0.7 (0.33–1.62)	0.9 (0.66–1.11)	0.7 (0.46–1.15)	0.9 (0.81–1)	0.9 (0.73–1.12)
30–39 versus >40	0.7 (0.45–1.09)	1 (0.46–2.12)	0.9 (0.72–1.16)	0.6 (0.37–0.99)	0.9 (0.84–1.03)	0.9 (0.72–1.1)

[a] Age in completed months or years on 1 March 1992. The analysis of the 1–10 years category was performed after the data were broken down into the following age categories: 12–23 months, 2–3 years, and 4–10 years.
[b] Figures shown in bold indicate that the vaccinations were significantly related to the factor considered ($P<0.05$).
[c] Figures in parentheses are the 95% confidence intervals.
[d] Logit estimator; Mantel–Haenszel estimator was not available.

group and vaccination level disappeared (Table 2).

The age of the mother was never significantly related to the vaccination of her child.

Thus, the obstacles to vaccination were mostly geographical. The vaccination status of a child depended mainly on the distance between the child's village and the health centre and on the village's location (on the plain or in the hills). The size of the village and the size of the compound also influenced the vaccination level but less significantly. The chances of being vaccinated increased with the size of the village and decreased with that of the compound.

Evolution of vaccination coverage since 1987. The variation of vaccination coverage with age is shown in Fig. 1. Following the special EPI efforts in 1986–87, 38% of children born in 1985 (6-year-olds at the beginning of 1992) and 46% of those born in 1986 were vaccinated three times. Subsequently the coverage fell to 28% for children born in 1987. The level was slightly better for children born in 1989 because of the renewed efforts in 1990; however, coverage then fell again, only 22% of children who were born during the previous 12 months having been immunized by March 1992. On the whole, immunization coverage has decreased since 1987.

Table 3: **Multiple logistic regression analysis of the probability of being vaccinated, by geographical and demographic factors, Bandafassi, February 1992**[a]

	Parameter[b]		Standard error (5% value)		Odds ratio		*P*-value	
	No. of times child vaccinated:		No. of times child vaccinated:		No. of times child vaccinated:		No. of times child vaccinated:	
	At least once	Three	At least once	Three	At least once	Three	At least once	Three
Intercept	3.87	3.37	0.33	0.27			0.0001	0.0001
Distance from the health centre (km)	–0.12	–0.12	0.009	0.01	0.89[c]	0.88[c]	0.0001	0.0001
Situation (hills/plain)	–1.21	–1.87	0.16	0.22	0.3	0.15	0.0001	0.0001
Size of the village (No. of inhabitants)	0.002	—	0.0005	—	1.002[d]	—	0.0002	—

[a] The following variables were tested: distance between child's village and health centre; location of village (on the plain or in the hills); size of village; size of child's compound; and number of children in the compound. Only those factors that significantly increased the predictive value of the model are shown.
[b] Parameters b_i in the equation: $P=1/[1+\exp-(a+b_1X_1+b_2X_2+...)]$.
[c] Per one more kilometre.
[d] Per one more inhabitant in the village.

This general trend nevertheless hides significant diversity. Fig. 2 shows the variations in vaccination coverage for three geographical groups. In group A (villages <10 km from the health centre), the vaccination coverage was 73% for children born in 1985 and this increased slightly to 80% for children born in 1991. For children in group B (villages on the plain 10–15 km from the health centre) vaccination coverage was 55% for children born in 1986 and remained at this level for those born up to 1990, but fell thereafter. In the remote villages of group C, vaccination coverage amounted to 22% for children

Fig. 1. **Variation in the proportion of children vaccinated, according to age and vaccination level, Bandafassi, February 1992.**

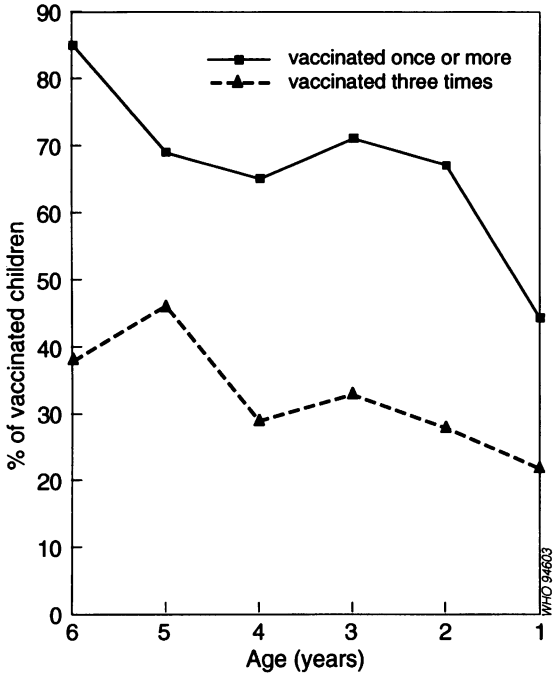

Fig. 2. **Variation in the proportion of children completely vaccinated, according to age and to distance from the health centre, Bandafassi, February 1992.**

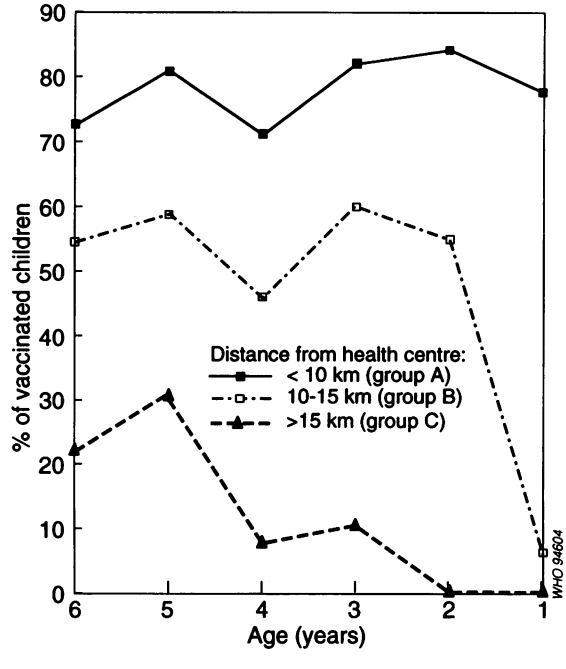

Table 4: **Number of vaccination sessions in the study area, by year and by village**

Village	No. of vaccination sessions in:				
	1987	1988	1989	1990	1991
Group A					
Etchwar	3	3	3	3	3
Nianie	3	2	3	3	3
Bundukundi	2	0	3	3	3
Patassi	3	1	0	3	2
Ibel	3	1	3	3	3
Group B					
Ndebu	0	0	0	1	1
Landieni	3	1	2	3	1
Tioketian	3	0	2	3	2
Group C					
Tiabedji	2	0	2	1	2
Andyel	0	0	0	0	0
Lande Baïtil	0	0	0	0	0
Namel	3	0	0	1	0
Iwol	0	0	0	0	1
Etyes	0	0	0	0	0
Mangama	0	0	0	0	1
Inere	0	0	0	0	0
Tiarmalel	0	0	0	0	0
Bandi	0	0	0	0	0
Kessema	0	0	0	0	0
Angoussaka	0	0	0	0	0
Kenda	0	0	0	0	0
Assoni	0	0	0	0	0

born in 1986, then decreased to just a few percent. None of the children aged 12–23 months in February 1992 had been vaccinated three times.

Vaccination efforts were thus unequally distributed within the rural study area, as illustrated also by the number of vaccination sessions by year and village (Table 4). EPI services hardly touch villages that are difficult to reach by car.

Discussion

Child mortality has declined steadily in the Bandafassi area over the last decade. The probability that a liveborn child will die before 5 years of age fell from 407 per 1000 in 1981–85 to 244 per 1000 in 1986–90 (*4*), largely because of the increased efforts of EPI in 1986–87. Immunization protects children against killer epidemics such as measles, and it appears that it increases children's resistance against diseases in general: vaccination against measles increases the survival of children more than would be expected simply from the effect of suppressing measles deaths (*5*). These probabilities show how important it is to obtain high immunization coverage in rural populations in order to reduce the still considerable levels of child mortality. In the study, we inferred time trends in vaccination coverage from the instantaneous vaccination coverage of different age groups. Since vaccinated children would be expected to have lower mortality than non-vaccinated children, the vaccination coverage obtained will be an overestimate. However, the magnitude of the overestimation should be slight since there have been no epidemics in the study area since 1987. In any case, this bias does not affect the conclusions with regard to trends.

Immunization coverage was practically zero in Bandafassi before the 1987 national campaign; this campaign completely changed the situation. Three-quarters of children under 5 years of age were vaccinated that year in almost all the villages in the area. Subsequently, coverage has varied according to the distance between the villages and the health centre. In the six villages nearest the centre, vaccination coverage increased to 80% of children; in the three villages farther away from the centre, but located on the plain and easily accessible by motorcycle, the coverage decreased to about 50%; and in the 14 remote villages, only a small percentage of the children were vaccinated.

The 1987 campaign owed its success to the action taken by the authorities to reach all villages: in particular, mobile teams were set up to vaccinate villages too far from the health centres, and the inhabitants of villages where vaccinations were not performed were persuaded to bring their children to sessions organized in other villages. However, these efforts lacked continuity. In Bandafassi, the mobile teams have stopped functioning and mothers hardly ever bring their children to other villages for vaccination. Nevertheless, in those villages that depend on the health centre, vaccination coverage has been maintained. In the Bandafassi area, enormous differences exist between villages where the level is quite satisfactory and others where virtually no vaccination is carried out at all because they are difficult to reach.

Our findings confirm how important it is for EPI to reach each village. Clearly, mothers are not sufficiently convinced of the importance of vaccination to carry their children to other villages to be vaccinated. In fact, in the study area the intervals between epidemic outbreaks in the same villages were extremely long, greater than 10 years in most cases (*6*). Hence, 5 years after the beginning of the accelerated immunization effort was too short a time for the inhabitants to have appreciated the impact of vaccination on child mortality. Development of parental awareness would be a major step forward, but it may be a

lengthy process. For the time being, vaccination sessions must be increased in order to reach all villages, however small. In the EPI strategy developed with this aim in view, the mobile teams are the weak link. According to EPI managers, technical difficulties are at the root of this (*7*). However, the problem is more than this: some mobile teams never visit the villages for which they are responsible. The mobile teams clearly have to be "resuscitated" and better organized. In this respect, veterinary mobile teams might serve as a useful example, because the organization of cattle vaccination is efficient and successful in many West African countries.

The mobile vaccination teams are therefore the main weakness of the EPI strategy for rural areas. Even if the mobile teams cannot achieve the same results as dispensaries, since only a few immunization sessions occur each year and the vaccination timetable cannot always be respected, with many children being immunized too late to be fully protected, revitalization of their programme in remote villages could result in a rapid improvement of the vaccination coverage.

Acknowledgements

We thank the following individuals: Dr A. Ndoye, Chief Medical Officer, Region of Tambacounda; Dr I. Deme, Chief Medical Officer, Kedougou Hospital; Mr I. Mansali, Health Assistant, Bandafassi; and Mr F. Keita and Mr F. Kamara. The study was supported financially by the Museum national d'Histoire naturelle, the Institut national d'Etudes démographiques, the Centre national de la Recherche scientifique (URA 49), and the Ministère de la Recherche, France. We thank also ORSTOM, Dakar, for logistic support. Peter Aaby's suggestions during the preparation of the manuscript are gratefully acknowledged.

Résumé

Obstacles à la vaccination infantile universelle dans les régions rurales du Sénégal 5 ans après la campagne nationale d'accélération du programme élargi de vaccination

L'objectif poursuivi par l'OMS et l'UNICEF, depuis les débuts du PEV (Programme élargi de Vaccination) en 1974 était: "80% des enfants vaccinés en 1990". Si au niveau mondial ce chiffre a été atteint, il reste des points faibles, comme l'Afrique. Au Sénégal, par exemple, la couverture vaccinale n'était que de 60% en 1990, en partie à cause des zones rurales où peu d'enfants sont vaccinés. Le PEV est organisé sur un double mode dans ce pays: les centres de santé vaccinent les enfants des villes et ceux des villages situés à moins de 15 km d'un centre de santé, et des équipes mobiles sont responsables de la vaccination dans les villages plus éloignés.

Afin de déterminer quels sont les obstacles au PEV en région rurale, une enquête de couverture vaccinale a été effectuée en février 1992 dans la zone de Bandafassi, au Sénégal. Cette zone d'étude, située dans le département de Kédougou, dans la région de Tambacounda, rassemble 6078 personnes réparties en 23 villages; elle fait l'objet d'une surveillance démographique depuis 1975. L'enquête de 1992 a permis de mesurer le niveau et l'évolution de la couverture vaccinale de cette zone, de décrire en détail les variations de la couverture d'un village à l'autre et d'en comprendre l'origine.

Il en ressort que 41% seulement des enfants de 1 à 10 ans sont complètement vaccinés au 1er février 1992 dans cette zone; 74% sont vaccinés au moins une fois. Mais cette proportion varie selon les villages, en relation essentiellement avec leur difficulté d'accès: un enfant a d'autant moins de chances d'être vacciné qu'il habite un village éloigné du poste de santé et situé en altitude. Dans une moindre mesure, la couverture vaccinale augmente avec la taille du village où vit l'enfant, et diminue avec la taille de son carré d'habitation (sous-unité villageoise correspondant à la famille patrilinéaire élargie). Par contre, l'ethnie et l'âge de la mère ne paraissent pas avoir d'influence sur la couverture vaccinale d'un enfant. L'évolution de l'effort vaccinal s'avère différente selon la situation géographique des villages: depuis la campagne nationale d'accélération de 1987, l'effort s'est maintenu dans les villages les plus proches du poste de santé. Par contre, il s'est rapidement dégradé dans les villages éloignés. La cause principale en est le non-fonctionnement des équipes mobiles, qui n'assurent pas de séances de vaccination dans les villages éloignés, comme cela avait été prévu. A ce défaut dans les structures s'ajoute une absence d'initiative des habitants, qui ne se déplacent pas pour aller faire vacciner leurs enfants dans d'autres villages lorsque des séances de vaccination y sont organisées.

Ainsi, la priorité actuelle en vue d'améliorer la couverture vaccinale dans les zones rurales est de rétablir des séances de vaccination dans les villages éloignés du poste de santé: cela implique une réorganisation complète des équipes mobiles afin de les rendre effectivement actives.

References

1. Expanded Programme on Immunization: Global Advisory Group. *Weekly epidemiological record*, 1989, **64**: 5–10.
2. **Pison G, Langaney A.** The level and age pattern of mortality in Bandafassi (Eastern Senegal): results from a small-scale and intensive multi-round survey. *Population studies*, 1985, **39**: 387–405.
3. **Bouyer J.** La régression logistique en épidémiologie. *Revue d'épidémiologie et de santé publique*, 1991, **39**: 183–196.
4. **Pison G, Desgrées du Loû A.** Bandafassi. Niveaux et tendances démographiques 1971–1991. *Dossiers et recherches de l'INED*, 1993, **40**: 1–40.
5. **Aaby P.** Determinants of measles mortality: host or transmission factors? *Medical virology*, 1991, **10**: 83–116.
6. **Pison G et al.** Increased risk of death from measles in children with a sibling of opposite sex in Senegal. *British medical journal*, 1992, **304**: 284–287.
7. **Ministère de la Santé publique et de l'Action sociale et Service national des grandes Endémies.** Compte rendu du conseil interministériel sur le PEV. *Epi 2000, nouvelles du PEV au Sénégal*, 1992, **2**: 2–4.